AVIRAL CLASSES
IIT-JEE | NEET | FOUNDATIONS

CHEMISTRY
CRASH COURSE

LECTURE - 02

TOPICS : Atomic Structure

1. The limiting line in Balmer series will have a frequency of
(a) $6.22 \times 10^{15}\ s^{-1}$
(b) $7.22 \times 10^{14}\ s^{-1}$
(c) $8.22 \times 10^{14}\ s^{-1}$
(d) $9.22 \times 10^{14}\ s^{-1}$

2. If the electron falls from n = 5 to n = 4 in the H-atom, then emitted energy is
(a) 0.306 eV (b) 12.09 eV
(c) 1.89 eV (d) 0.65 eV

3. The number of radial nodes and angular nodes for d-obrital can be represented as
(a) (n– 2) radial nodes + 1 angular node = (n – 1) total nodes
(b) (n– 1) radial nodes + 1 angular node = (n – 1) total nodes
(c) (n– 3) radial nodes + 2 angular node = (n – l – 1) total nodes
(d) (n– 3) radial nodes + 2 angular node = (n – 1) total nodes

4. The correct set of quantum numbers for the outermost electron of Rubidium (37) is
(a) $5, 0, 0, +\frac{1}{2}$ (b) $4, 3, 2, -\frac{1}{2}$
(c) $5, 1, 0, -\frac{1}{2}$ (d) $5, 1, 1, +\frac{1}{2}$

5. In any subshell, the maximum number of electrons having same value of spin quantum number is
(a) $\sqrt{l(l+1)}$ (b) $l + 2$
(c) $2l + 1$ (d) $4l + 2$

6. A golf ball has a mass of 40 g, and a speed of 45 m/s. If the speed can be measured within accuracy of 2%, calculate the uncertainty in the position.
(a) 1.46×10^{-33} m
(b) 1.46×10^{-33} cm
(c) 1.59×10^{-33} m
(d) 5.27×10^{33} km

7. Calculate the uncertainty in the momentum of an electron if it is confined to linear region of length 1×1^{-10} metre.
(a) 5.37×10^{-27} kg ms^{-1}
(b) 5.27×10^{-25} g ms^{-1}
(c) 5.37×10^{-25} g ms^{-1}
(d) 5.27×10^{-25} kg ms^{-1}

8. Based on equatin $E = -2.178 \times 10^{-18}\ J \left(\frac{Z^2}{n^2}\right)$, certain conclusions are written. Which of them is not correct ?
(a) Equation can be used to calculate the change in energy when the electron changes orbit.
(b) For n = 1, the electron has a more negative energy than it does for n = 6 which means that the electron is more lossely bound in the smallest allowed orbit.
(c) The negative sign in equation simply means that the energy of electron bound to the nucleus is lower than it would be if the electrons were at the infinite distance from the nucleus.
(d) Larger the value of n, the larger is the orbit radius

9. The ionization enthalpy of He^+ ion is 19.60×10^{-18} J atom^{-1}. The ionization enthalpy of Li^{2+} ion will be
(a) 84.2×10^{-18} J atom^{-1}
(b) 44.10×10^{-18} J atom^{-1}
(c) 63.20×10^{-18} J atom^{-1}
(d) 21.20×10^{-18} J atom^{-1}

10. Which transition in the hydrogen atomic spectrum will have the same wavelength as the transition, n = 4 to n = 2 of He^+ spectrum ?
(a) n = 4 to n = 3
(b) n = 3 to n = 2
(c) n = 4 to n = 2
(d) n = 2 to n = 1

AVIRAL CLASSES
IIT-JEE | NEET | FOUNDATIONS

PHYSICS CRASH COURSE

LECTURE - 02

TOPICS : Atomic Structure (SOLUTION)

1. **(c) :** The limiting line of Balmer series refers to the transition of electron from ∞ to 2^{nd} orbit $\upsilon = c.\bar{\upsilon}$

$$= 3 \times 10^{10} \times 109677\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = 3.29 \times 10^{15}\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \text{sec}^{-1}$$

$= 8.22 \times 10^{14}$ sec^{-1} ($n_1 = 2$, $n_2 = \infty$)

2. **(a) :** $E_n = -\frac{13.6}{n^2}$ eV

$$E_5 - E_4 = 13.6\left(\frac{1}{4^2} - \frac{1}{5^2}\right) \text{eV} = 13.6\left(\frac{1}{16} - \frac{1}{25}\right) = 0.306 \text{ eV}$$

3. **(d) :** Total number of nodes = $n - 1$
For d-orbital, radial nodes = $n - 3$ and there are 2 angular nodes.
The number of angular nodes is given by l. *i.e.*, for p, 1 angular node, for d, 2 angular nodes and so on.

4. **(a) :** Outermost electron of Rb (At. no. 37) is 5s. Hence, its quantum numbers are 5, 0, 0, $\pm 1/2$.

5. **(c) :** Maximum number of electrons with same spin is equal to the maximum number of orbitals *i.e.*, $(2l + 1)$.

6. **(a) :** The uncertainty in the speed is 2%, *i.e.*,

$45 \times \frac{2}{100} = 0.9 \text{ m s}^{-1}$. Using the equation, $\Delta x = \frac{h}{4\pi m \Delta v}$

$$= \frac{6.626 \times 10^{-34} \text{ J s}}{4 \times 3.14 \times 40 \times 10^{-3} \text{ kg } (0.9 \text{ m s}^{-1})} = 1.46 \times 10^{-33} \text{ m}$$

This is nearly ~ 10^{18} times smaller than the diameter of a typical atomic nucleus. As mentioned earlier for large particles, the uncertainty principle sets no meaningful limit to the precision of measurements.

7. **(d):** According to uncertainty principle,

$$\Delta x \cdot \Delta p = \frac{h}{4\pi} \quad \text{or} \quad \Delta p = \frac{h}{4\pi \Delta x}$$

$$\Delta p = \frac{(6.626 \times 10^{-34}\ \text{kg m}^2\ \text{s}^{-1})}{4 \times 3.143 \times (10^{-10}\ \text{m})} = 5.27 \times 10^{-25}\ \text{kg m s}^{-1}.$$

8. **(b):** The electron is more tightly bound in the smallest allowed orbit.

9. **(b)** : Ionisation enthalpy $\propto Z^2$ (Z = Atomic number)

Ionisation enthalpy of Li^{2+} = $I.E.$ of $He^+ \times \left(\frac{3^2}{2^2}\right)$

$I.E.$ of $Li^{2+} = 19.6 \times 10^{-18} \times \frac{9}{4} = 44.1 \times 10^{-18}$ J atom^{-1}

10. **(d):** For He^+ ion,

$$\frac{1}{\lambda} = Z^2 R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \Rightarrow (2)^2 R\left[\frac{1}{2^2} - \frac{1}{4^2}\right] = \frac{3R}{4}$$

For hydrogen atom, $\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$$\frac{3R}{4} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \quad \text{or} \quad \frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{3}{4}$$

$n_1 = 1$ and $n_2 = 2$.